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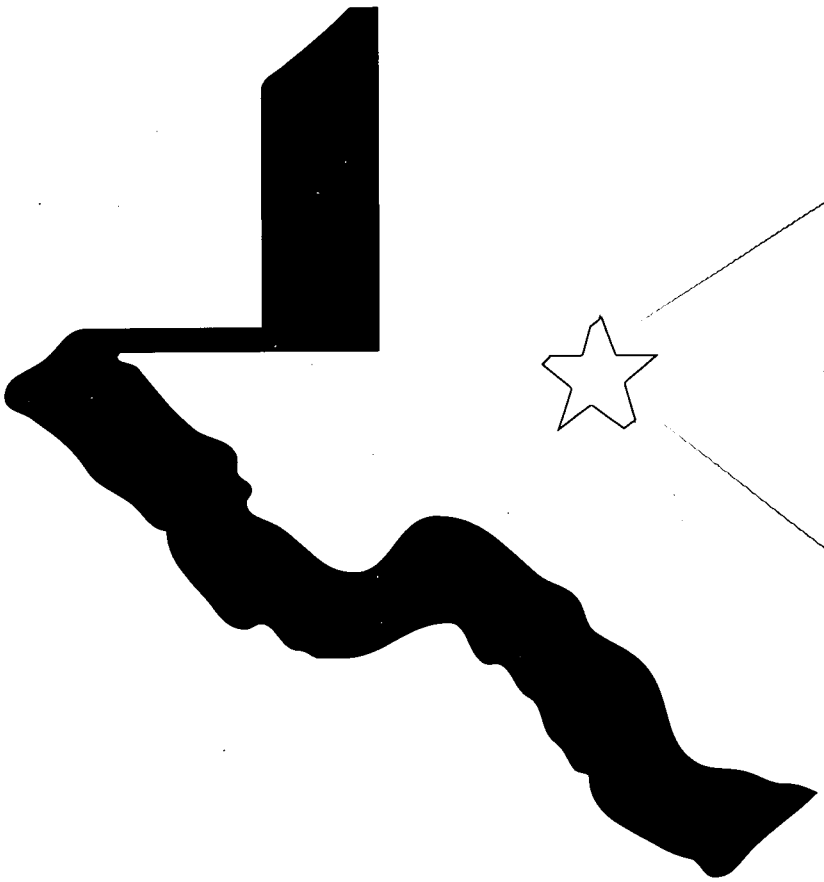
ABSTRACT

This report focuses on the imperative to prepare teachers to understand and use technology. Drawing on the experience of the Texas Centers for Professional Development of Teachers (CPDTs), the report illustrates how CPDTs are exploring models of instruction built on the International Society for Technology in Education (ISTE) standards and incorporating them into teacher education experiences. Section 1 presents a background and overview of technology in Texas teacher education, looking at technology and CPDTs and technology in professional development schools. Section 2 offers snapshots of technology and teacher education, focusing on four different universities. Section 3 presents an in-depth look at one CPDT, highlighting the Center for Educational Development and Excellence (CEDE), one of the largest and best-funded CPDTs. The report concludes that most teacher education institutions have expended enormous amounts of time and energy in acquiring equipment for their students and faculty, with associated training often not fitting the curriculum or the needs of the students. During the past 5 years, the CPDTs have begun to deal with this issue in a collaborative model that has benefitted both preservice and inservice teachers and their students throughout Texas. The report presents eight recommendations for how schools of education can infuse technology into curricula and prepare teachers who can use technology in their professional practice. (Contains 11 references.) (SM)

Restructuring Texas Teacher Education Series 7



Technology

Texas State Board for Educator Certification

CENTERS FOR PROFESSIONAL DEVELOPMENT OF TEACHERS

In 1991 the Texas Legislature passed legislation and authorized funding for the Centers for Professional Development of Teachers (CPDTs; originally called Centers for Professional Development and Technology). The CPDTs are designed to support collaboration among public schools, universities, regional education service centers, and other organizations to improve teacher preparation and professional development.

The purpose of the CPDTs is to totally restructure teacher education on the basis of six principles and goals:

- To restructure teacher preparation programs toward performance-centered, field-based models
- To institutionalize the new programs to include all prospective teachers for the long term, not just pilot groups for a short period
- To integrate technology into teacher preparation and to support its enhanced use in PreK–12 schools
- To prepare teachers to address the needs of culturally diverse student populations
- To extend collaboration among universities, schools, and others concerned with teacher preparation
- To establish staff development opportunities that better address the needs of all educators

In 1992 the state funded the first 8 CPDTs. By 1993 the number had increased to 14, and by 1997, to 30. The CPDTs now comprise 43 universities, 15 regional education service centers, and 113 school districts, affecting more than 300,000 students, 19,000 teachers, and 12,000 preservice teachers. The names and the locations of the CPDT universities appear on the inside back cover of this publication. The commitment by the state legislature has been significant, as indicated by the $46 million that it has provided to date.

ABOUT THIS SERIES

This series of seven reports on restructuring teacher education in Texas was produced by representatives of seven CPDT institutions that received 1997–98 grants for Partnerships for Professional Development of Teachers. The series draws on experiences of all the CPDTs, including both successes and challenges.

The seven reports are as follows:

- Field-Based Teacher Education
- Professional Development Schools
- Connecting to Improve Methods Courses
- Assessment
- Distance Learning
- Cultural Pluralism
- Technology

Technology and Teacher Education

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INTRODUCTION

During the past two decades, virtually every sector of American society has felt the influence of microtechnology. The huge education enterprise, from kindergarten through graduate school, has not been immune to this spread of computers, laser discs, and various other electronic modes of learning. Nonetheless, technology has not profoundly revolutionized teaching and learning. For the most part, expected changes have been only partially achieved.

AN ANALOGY TO THE AUTOMOBILE

An analogy, the introduction of the automobile in the early part of the 20th century, may help readers fathom the pace at which schools and colleges are accepting and using technology. The automobile was a radical departure from the horse and carriage. The cost of the "horseless carriage" was prohibitive for most people. It required manipulative skills. The speed at which it moved was frightening and confusing, and there were few good roads and services to support travel in it. Twenty years passed before Henry Ford advanced from an experimental car in 1893 to conveyer-belt production in 1913. The electric starter did not come until 1912, balloon tires until 1921. But automobiles gradually became more user friendly. From 1910 to 1920, registrations grew from 458,300 to more than 8.1 million (from one car for every 197 people to one car for every 12.9 people). Still, possession of an automobile was not fairly common until about 1930, and even then only about 23 million passenger vehicles were on American highways (one for every 5.3 people). By 1950, though, there was one car for every 3.7 people, and by 1995 one for every 1.9 people. Achieving universal use of automobiles has taken more than eight decades.

In the 1970s a television cartoon, "The Jetsons," introduced a car of the future that flew through space at high speed and moved the family from point to point with little time or stress and without the constraints of the highway system that Americans know today. Although this was clearly fantasy, many wondered what the next half century would bring. Today, even as people struggle with the expense of car maintenance and repair, and the headache of traffic, they fully embrace the car as a necessity. They also accept that a change as profound as the Jetson mobile will not come about easily, cheaply, or quickly.

About two decades ago, a vision began of a futuristic classroom in which each student had a laptop computer that traveled with him or

> *"Most United States teachers have not had enough training to employ technology in their teaching."*

her throughout the day at school and at home. The classroom had interactive videoconferencing capabilities, and students had direct access to the Internet. Class presentations were enhanced with various technologies—videos, laser discs, computer projection devices, etc. Students submitted assignments electronically and received grades the same way. There was no longer a need for paper and pencils or even textbooks. Now, nearly two decades later, such classrooms have not materialized in most schools. The idea remains that technology, like cars, is necessary if students are to be more productive and efficient. But it is time to recognize that a change as profound as the futuristic classroom will not come easily, cheaply, or quickly.

CURRENT REALITY

Numerous authors have written about the mind-boggling possibilities of technology, the imperative that students and teachers be educated to function in a technologically rich environment, and the stunted implementation of technology in schools and teacher preparation programs. In recent months alone, technology has been the focus of two major reports (NCATE, 1997; President's Committee, 1997), a special edition of *Education Week* ("Technology Counts," 1997), and special sections of the *Wall Street Journal* ("Technology," 1997) and the *New York Times* ("Personal Technology," 1997). These publications acknowledge that although many schools have received considerable amounts of hardware and software, they have not integrated technology into their program or used it to anywhere near its full capacity. Most United States teachers have not had enough training to employ technology in their teaching. Only 15 percent report having at least nine hours of preparation in the area (Educational Testing Service, 1997).

Further, only 18 states require training in computers or technology for all teachers seeking licensure (U.S. Congress, Office of Technology Assessment, 1995). These requirements vary across states. Some states, like Texas, require a three-credit course. Other states, like Idaho and Wisconsin, mandate that programs follow the preservice guidelines for technology training developed by the International Society for Technology in Education (ISTE) and approved by the National Council for Accreditation of Teacher Education (NCATE). The ISTE standards include a basic understanding of computer and technology operations and concepts, a knowledge of personal and professional uses of technology, and competence in application of technology to instruction.

NCATE has integrated five professional standards in technology into its accreditation process (Cooper & Bull, 1997). For a description of them, see Exhibit 1.

Exhibit 1
1995 NCATE Accreditation Standards Related to Technology Standard Descriptor

	Standard	Descriptor
I.C.1	Content Studies for Initial Teacher Preparation	expects candidates to develop an understanding of the uses of technology for the subjects they plan to teach
I.D.2	Professional and Pedagogical Studies	expects professional studies to include knowledge and experiences with "the impact of technological and societal changes on school," and with "educational technology, including the use of computer and related technologies in instruction, assessment, and professional productivity"
III.A.1.	Professional Education Faculty Qualifications	now has an indicator that expects "higher education faculty [to be] knowledgeable about current practice related to the use of computers and technology and [to] integrate them in their teaching and scholarship"
IV.B	Resources for Teaching and Scholarship	contains an indicator that expects "higher education faculty and candidates [to] have training in and access to education-related electronic information, video resources, computer hardware, software, related technologies, and other similar resources"
IV.C	Resources for Operating the Unit	contains three indicators requiring that the facilities and equipment be well maintained and that they be at least at the level of other units in the institution

Note. From "Technology and Teacher Education: Past Practice and Recommended Directions" (p. 100), by J. M. Cooper & G. L. Bull, 1997, *Action in Teacher Education, 19*(2), 97–106. © 1997 by Association of Teacher Educators. Reprinted with permission.

A report by the U.S. Congress, Office of Technology Assessment (1995), notes that, overall, the nation's teacher education institutions do not yet adequately prepare their graduates to use technology as a teaching tool. In fact, even the states that require preparation of preservice and inservice teachers to use technology often do not have enough classrooms in which teachers can observe the uses of technological tools and engage in practice with them. Yet other studies paint a much more optimistic picture—for example, the report of a 1996 survey distributed as a part of the Joint Data Collection System of NCATE and the American Association of Colleges for Teacher Education (AACTE, 1997). See Exhibit 2 for survey findings in three categories: student use of technology, faculty use of technology, and institutional capacity.

There is no argument that future teachers must be technologically literate as a result of their professional education. Not only are schools placing greater emphasis on the use of technology as a teaching and learning resource, but the world outside school is becoming increasingly technologically dependent. For the 21st century, teacher training that does not include a wide variety of technological experiences will not be adequate at all. The imperative to prepare teachers to understand and use technology is the focus of this report. Drawing on the experience of the Texas Centers for Professional Development of

Exhibit 2
Use of Technology in Schools of Education

Student Use of Technology

- Eighty-five percent of SCDEs require students to take a course on computer applications, and 61% require course work on computer use, communications, and instructional integration.
- Students at 69% of SCDEs must demonstrate the use of at least one technology both on campus and during student teaching.
- Students at virtually all SCDEs (98%) sometimes use computers, televisions, and VCRs to share information in the classroom setting.
- Students at 81% of SCDEs submit assignments completed using computer applications, and at 64% of SCDEs they may submit their work via e-mail.

Faculty Use of Technology

- Almost half of SCDE faculty (45%) regularly use computers, televisions, and VCRs as an interactive instructional tool during class periods.
- The faculty at 98% of SCDEs occasionally use technology to present information during class, and at 78% of SCDEs to conduct research and communicate with peers.
- Faculty use distance education technologies for highly interactive instructional purposes at 49% of SCDEs.
- Over half of SCDEs' faculty (52%) do not have access to technology that supports interactivity or have no distance technology available.

Institutional Capacity

- The administrators at 78% of SCDEs communicate with faculty and staff via e-mail.
- Of the 98% of SCDEs that have televisions and VCRs available for instructional purposes, 42% are wired for the Internet and have computers available.
- Fifty-seven percent of SCDEs deliver instruction to off-site students using computers, videos, text, or faculty travel.
- Students at 57% of SCDEs have access to the most advanced electronic technologies and software applications.
- Fifty-five percent of SCDEs have budgeted a plan to purchase, replace, and upgrade a variety of educational technologies.

Note. SCDEs = Schools, colleges, and departments of education. From *The Use of Technology in Schools, Colleges and Departments of Education: Myths & Reality* (p. 1), by American Association of Colleges for Teacher Education, 1997, Washington, DC: Author.

Teachers (CPDTs; originally called Centers for Professional Development and Technology), the report illustrates how CPDTs are exploring models of instruction built on the ISTE standards and incorporating them into teacher education experiences.

BACKGROUND AND OVERVIEW OF TECHNOLOGY IN TEXAS TEACHER EDUCATION

In 1991 the Texas Legislature, hearing a wide variety of criticisms concerning the preparation of preservice and inservice teachers, created the CPDT program to provide a structure in which colleges and universities could join with public school districts to attack this problem. The long-term goal of the program is to broaden the education of prospective teachers through collaborative relationships among universities, PreK–12 schools, and regional service centers. In both their preservice and their inservice components, the CPDTs are to emphasize the use of technology.

Technology and the CPDTs

The Texas Education Agency's guidelines for CPDT applications invited proposals for projects that would facilitate integration of technology into the preparation of teachers to manage curriculum and instruction in learner-centered classrooms. It was anticipated that CPDTs would not only prepare a new generation of high-quality teachers but upgrade the teaching knowledge and technology skills of practicing teachers. The CPDTs were to promote the professional development school (PDS) as a model for the role that technology might play in the preparation of technologically competent teachers.

Technology and PDSs

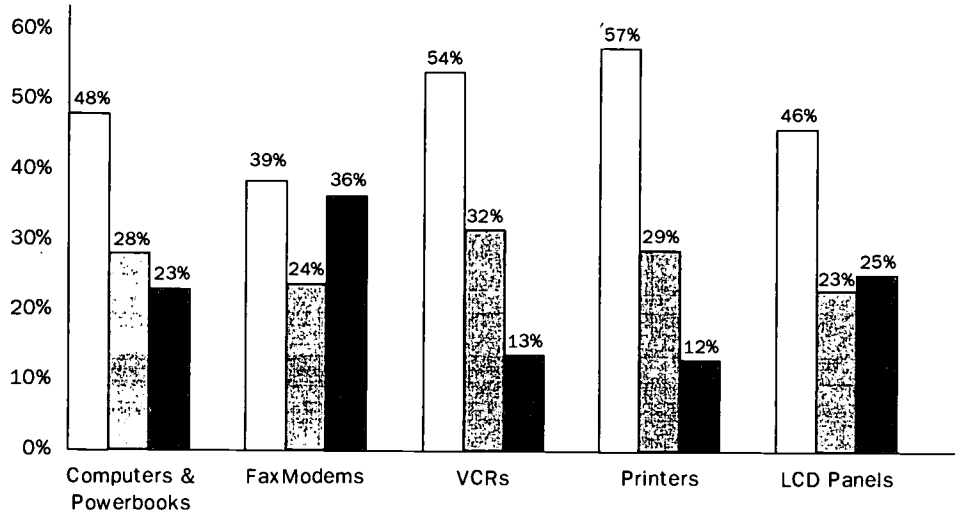
Recently there have been dramatic increases nationally in students' access to computers. During the 1994–95 school year, schools spent approximately $3.3 billion on technology (U.S. Congress, Office of Technology Assessment, 1995). Access to technology in Texas schools also has risen sharply, although there remains great variability both within and across school districts. Unfortunately, in many instances, teacher education programs have not kept pace.

The CPDTs provided funding for about 4,500 computers for elementary and secondary schools and universities (Macy Research Associates, 1996). In some instances this funding supported the greatest infusion of technology ever experienced by either the PDS or the teacher education program. For the distribution of selected items of hardware purchased and installed by the CPDTs, see Exhibit 3.

Videoconferencing systems are another important technology resource provided through the CPDT. At present, sixteen CPDTs have two or more videoconferencing units connected to school campuses, universities, or junior colleges. The systems established by CPDTs at the Panhandle/South Plains, Southwest Texas State University, Stephen F. Austin State University, and others provide instruction to students in the school and professional development opportunities for preservice and experienced teachers. The systems have proven particularly useful in supporting collaboration and communication between the universities and remote PDS sites. The use of the distance-learning technologies has brought new challenges to collaborative partners in coordinating distance-learning course schedules, bridging established boundaries between educational institutions, dealing with limited compatibility between videoconferencing systems, and confronting differences in type and level of connectivity (Yearwood, 1998). The CPDTs are at the forefront in addressing these issues. Their pioneering efforts are particularly important in light of the growing state and national commitment to connectivity in schools and the resources being devoted to it.

"It was anticipated that CPDTs would not only prepare a new generation of high-quality teachers but upgrade the teaching knowledge and technology skills of practicing teachers."

Exhibit 3
Selected Hardware Installation by Institutional Level



Note. From *Centers for Professional Development and Technology state-wide evaluation study: Final summary report* (p. 31), by Macy Research Associates, 1996, Wills Point, TX: Author.

In addition to hardware, the CPDTs have supplied PDSs with software, training, and support. Over a four-year period, they have provided technology training to 17,000 educators, including 8,000 classroom teachers, 7,000 preservice teachers, 900 university faculty, and 650 school administrators. Many of the CPDTs also offer on-site technical support for classroom teachers, faculty, and preservice students in the PDS.

As noted by Macy Research Associates (1996), although some of the CPDT directors indicated that equipment, software, training, and technical resources were adequate to meet current and near future needs, others expressed concern about securing the funding needed to maintain, update, and replace aging hardware and software. To understand the basis for concern, it is necessary to recognize that, before CPDT funding, some teacher preparation programs provided less technology access to students than was available to many middle school students across the state and the country. A common problem reported by the CPDT university personnel was the very limited equipment

funding they typically received from their central administration. Some felt that they were at the bottom of the university's priority list for equipment funding, despite the fact that in many instances their college generated among the largest numbers of student credit hours (and therefore funding) for the university. The CPDT university personnel also expressed concern about the continued availability of training and technical support to help existing PDS teachers and college faculty learn and incorporate new technology tools into their instruction, as well as to train and support new PDS teachers and faculty.

The concerns of some of the CPDT directors require careful attention. Although the provision of resources to the PDS through the CPDT program has proven of great value, the benefits of the technology infusion will erode over time if sufficient resources and funding are not provided to continue updating the equipment in the PDS and teacher preparation programs. The CPDT collaboratives together must be proactive in helping university central administrations, school boards, the Texas Education Agency, the Higher Education Coordinating Board, the regents, and the legislature understand the need to continue supporting and expanding the infusion of technology into PDSs and teacher preparation programs. Failure to do so will ensure that teachers in the 21st century will be unprepared to apply technological resources and tools effectively in instruction.

"Although the provision of resources to the PDS through the CPDT program has proven of great value, the benefits of the technology infusion will erode over time if sufficient resources and funding are not provided to continue updating the equipment in the PDS and teacher preparation programs."

SNAPSHOTS OF TECHNOLOGY AND TEACHER EDUCATION

One of the charges to the CPDTs was to restructure preservice and inservice teacher education to make technology an integral part of it. Across the state, CPDTs envisioned this mandate in diverse ways. This section presents "snapshots" of four universities that are parts of CPDTs—Stephen F. Austin State University, Southwest Texas State University, the University of Texas at El Paso, and the University of Houston. Each snapshot focuses on a different facet of realizing a shared vision: the Stephen F. Austin snapshot on creation of a master plan to guide the CPDT's work; the Southwest Texas State snapshot on extensive integration of technology into a PDS to enhance learning of preservice teachers and elementary school students and teachers; the University of Texas at El Paso snapshot on integration of educational technology into the teacher education program; and the University of Houston snapshot on use of telecommunication innovations by members of its consortium.

Stephen F. Austin State University

Technology is a cornerstone of the Stephen F. Austin CPDT's restructuring effort. Increased use of technology by all partners in the CPDT,

"The conference showcased new equipment and software, and teachers and professors shared experiences using technology in instruction. The conference was so successful that it was repeated the second year and now has become an annual event."

at all educational levels, has been the goal. Key elements of achieving that goal are as follows:

- Establishing a Technology Action Team of teachers and professors to make decisions and take action
- Employing a technology specialist to work exclusively for the CPDT
- Purchasing hardware and software for the College of Education and the PDSs
- Requiring technology courses for all preservice teachers
- Developing a continuing program of staff development in technology for practicing teachers
- Allocating the largest share of the original CPDT grant for technology equipment, training, and software

Efforts in the First Year

In the first year, the Technology Action Team met monthly because it had so many decisions to make about hardware and software orders, placement of equipment, and staff development. In addition, it had set an ambitious goal of hosting a regional technology conference at the end of the year. The conference showcased new equipment and software, and teachers and professors shared experiences using technology in instruction. The conference was so successful that it was repeated the second year and now has become an annual event. Currently the Technology Action Team meets about once a semester; however, the conference planning committee meets more frequently. One result of the Technology Action Team has been a technology advisory group for the College of Education Technology Center.

Also in the first year, the CPDT established field-based classrooms at each PDS to serve as training stations, and a pilot group of prospective teachers began pre-student-teaching fieldwork. The CPDT equipped each classroom with a complement of computers (10 per classroom), CD-ROM drives, video projectors, cameras, high-brightness projectors, printers, and copiers. In addition, at each PDS the CPDT made available a technology cart that included all these items. Further, the CPDT provided mentor teachers with a computer for use in their classrooms. In the first year, more than a million dollars was spent on technology equipment, and more than half of the equipment was placed in the public schools.

The Technology Action Team also developed a plan for a distance-learning laboratory, placing videoconferencing equipment on the university campus and at several remote sites: first Angelina College,

later the Region VII Education Service Center and the University of Texas Medical Branch at Galveston.

The CPDT employed a technology specialist, who brought skills in instruction, technology, and teamwork to the program. As the field-based teacher preparation program gradually became institutionalized, Stephen F. Austin assumed responsibility for the technology specialist's salary. He now teaches credit courses in instructional technology to preservice teachers and is responsible for the university's technology laboratory on campus. Elementary and secondary education school faculty skilled in instructional technology provide additional modeling and instruction for preservice teachers.

Refinement of the Plan

In the second year, the pilot program expanded to include all preservice teachers. At this point it became clear that the field-based classrooms could not support a semester of technology instruction for large numbers of preservice teachers. As a result, the technology laboratory on the university campus was enlarged to provide instruction in technology for all prospective teachers before they began their field-based semester.

As additional field sites have been added, technology training for preservice teachers has been reconceptualized. Less of it now occurs in the field because preservice teachers develop technology skills in campus-based courses. In addition, because public schools have more funds to buy computers for their teachers, the CPDT no longer supplies computers to mentor teachers.

Today the Distance Learning Laboratory has grown in both equipment and capacity to connect to multiple sites. Further, the distance-learning component has been institutionalized and now is managed by the university's Office of Instructional Technology. Faculty across the campus use the facility to deliver courses to remote locations and to confer with persons at other sites.

Currently, technology goals include collaboration with partner schools to obtain money from the state's Technology Infrastructure Fund. The money will permit public school partners to establish complete Internet connections and receive appropriate staff development. As a result, practicing teachers will be able to use technology to enhance student learning. Current goals also include upgrading of older computers and continuing staff development to meet the needs of all partners.

Southwest Texas State University

Restructuring of the preservice teacher education program shaped the technology initiative of the Southwest Texas State University CPDT. A basic premise of the CPDT was that preservice teacher education is most effective when it occurs in classrooms where technology is integrated into instruction. Toward this end, Southwest Texas State developed a field-based block program in which "interns" (prospective teachers) work in a collaborating PDS for a semester. At the PDS, interns spend half of the day in assigned classrooms, observing, working with students, and implementing their own lesson plans, some of which incorporate technology. They spend the remainder of the day in field-based university classrooms, where they are instructed by a university professor, sometimes via interactive videoconferencing.

Technologies

Bowie Elementary in the San Marcos Independent School District is one of the original schools participating in the CPDT. To ensure that preservice teachers assigned to Bowie Elementary are immersed in a technologically enriched context, each Bowie classroom participating in the project received a wealth of equipment: two telephone lines (one for voice and one for data transmission), four computers, a printer, a laser disc player, television connections, microphones, speakers, headphones, video digitizing boards, modems, and CD-ROM drives connected with Ethernet software. A variety of software appropriate for elementary school children also was acquired for each classroom—packages such as Kid Pix, HyperCard, Story Weaver, Claris Works, Slide Show, and SuperPaint.

A computer laboratory that the CPDT installed at Bowie provides additional technology access for project participants. The laboratory is equipped with 26 Macintosh computers, supporting printers and scanners, an LCD display panel, and hookups to the Internet and the Texas Educators Network (TENET). Preservice teachers and Bowie teachers, students, and parents may use the laboratory.

Further, the CPDT has established a university classroom at Bowie that has interactive videoconferencing equipment, including video cameras, videotape and laser disc players, and a computer-video interface. Even when Southwest Texas State faculty are on the university campus, they can remain in contact with their students via the videoconferencing equipment.

Training

To ensure that technology would become an integral part of the restructuring effort, the CPDT hired a technology specialist to provide

training for preservice and inservice teachers, university faculty members, parents, and community members. Preservice teachers receive two hours of training each week on tools such as word processing, databases, spreadsheets, and multimedia, and on integration of these tools into teaching. This training is coordinated with their university courses. For example, when students are studying the writing process, their technology training focuses on the use of word processing packages.

So that preservice teachers would see technology used in the field, the first inservice teachers participating in the CPDT were released from classes once a week for a semester, for technology training. As teachers have become competent users of technology, release time for training has decreased to once a month. Summer workshops offer further opportunities for technology training.

Continuing an activity begun several years ago to build connections between the school and the community, on Thursday evenings Bowie Elementary offers training in technology to community members. These sessions bring together Bowie students, teachers, parents, university faculty, and other members of the community. To involve parents in their children's education, the CPDT offers parent-student technology workshops at the school on Saturdays. University students teach these sessions. Parents have become so involved that the CPDT has added a second Saturday session to accommodate all those who are interested.

"Preservice teachers receive two hours of training each week on tools such as word processing, databases, spreadsheets, and multimedia, and on integration of these tools into teaching."

Results

CPDT participants have been pleased with the results of their restructuring efforts. Since the first year of the CPDT, Southwest Texas State and its public school partners have instituted a field-based model of high-quality preservice teacher preparation. The CPDT's attention to the technology component of the project has ensured that PDS teachers use technology as part of instruction and that preservice teachers develop the technology competencies that they will need in the 21st century.

An example of integrating technology into teacher preparation is the Southwest Texas State Teacher Fellow Program. Participants are fully licensed first-year teachers, all graduates of a teacher preparation program. They are enrolled in a fast-track master's degree program and assigned as full-time classroom teachers to one of six participating school districts. During their first summer in the program, fellows take 12 hours of graduate work, 3 hours of which are an educational technology course. In the technology course, they learn various uses of multimedia with an emphasis on enhancing instruction through technology.

As an application of their learning, the fellows investigate the school to which they are assigned and its surrounding community. Armed with a video camera and a digital camera, they collect information, then compile a 5- to 10-minute multimedia presentation using Persuasion software. They share their presentations at the end of the summer, in a celebration attended by their support teachers and other invited guests.

The community study projects not only give fellows practice in how they might use technology with their own students but also help familiarize them with their school and its community. The multimedia products have served several other useful functions. For example, a number of the teacher fellows have shared their products with their school faculties and at PTA meetings. Also, faculty of the Teacher Fellow Program have integrated segments of various products into professional presentations at state and national conferences.

University of Texas at El Paso

In the undergraduate and graduate teacher education programs at the University of Texas at El Paso, personal and professional uses of technology are an accepted and integral part of a student's professional growth. CPDT personnel have been influential in facilitating development of technology skills and demonstrating ways to use them in curriculum and instruction.

"Armed with a video camera and a digital camera, the fellows collect information, then compile a 5- to 10-minute multimedia presentation using Persuasion software. They share their presentations at the end of the summer, in a celebration attended by their support teachers and other invited guests."

For example, prospective teachers are encouraged to use E-mail to communicate with professors and peers, to submit journal entries, and to complete other class assignments. Also, they participate in "E-mail mentor projects," assisting elementary school students with homework. This relationship serves the dual purpose of involving prospective teachers with a broad spectrum of children (some of whom they might not ordinarily encounter) and getting them to practice their technology skills.

Technology use goes well beyond computers. For example, in the preservice course in science methods, prospective teachers learn applications of the laser disc. Faculty use interactive programs such as Windows on Science as examples of the latest laser/optic technology available for elementary school classrooms.

In the graduate program, students move from learning how to use and apply technology to writing and producing programs, reports, and assessment portfolios. In doing so, they develop skills that they can use in their future teaching.

University of Houston

In the University of Houston's Houston Area Consortium of Professional Development and Technology Schools, participants are creating an electronic community of learners and information specialists who develop and share a wide variety of multimedia resources. They are accomplishing this with a new generation of Internet tools featuring a graphical-user-interface (GUI) that makes file transfer simple. GUI tools allow network users to easily exchange not only text files but sound resources, video movie clips, and software application files from desktop computers. Instead of entering text commands, users simply point at and click on icons and menu bars. Among the GUI applications that consortium members are learning to use are Eudora, an E-mail program, and NCSA Mosaic, an Internet browsing program.

To support this activity, the consortium purchased, set up, and configured equipment for use as a telecommunication hub. The equipment includes a workstation, a computer server, high-speed modems, and telephone lines. Located in the College of Education at the University of Houston, the equipment is available for use by all members of the consortium.

As training in use and application of the equipment and software unfolded, it became apparent that more computers capable of telecomputing were needed. To meet the need and to allow members to connect from home, the consortium purchased additional laptop computers with built-in modems.

As the CPDT project has continued, so have its telecommunication efforts. For example, with the dramatic growth of the World Wide Web, more Consortium members have become interested in gaining dial-up access to the Internet from both school and home. Consortium members now have Internet access accounts, E-mail accounts, and server space for hosting their own Web pages, all free. In addition, members may download software without charge from the Consortium's Web site.

AN IN-DEPTH LOOK AT ONE CPDT: THE CEDE EXPERIENCE

The Center for Educational Development and Excellence (CEDE) was unique among the original CPDTs in being the largest and the best funded. Based in San Antonio, CEDE includes five universities (one public, four private; all four-year institutions): Our Lady of the Lake University, St. Mary's University, Trinity University, the University of Texas at San Antonio, and the University of the Incarnate Word. Other partners are the Alamo Area Community College District and six

school districts. The universities participating in CEDE share the goal of other CPDTs, that of restructuring preservice and inservice teacher education in a field-based mode and making technology an integral part of that process. This section provides snapshots of some of the most promising technology practices of CEDE partners and describes a major collaborative effort, the Summer Institutes.

Our Lady of the Lake University

To facilitate preservice teachers' acquisition of competencies in technology, Our Lady of the Lake University has established a computer laboratory at St. Martin Hall Elementary School, one of the university's PDSs. Training modules have been developed to ensure that preservice teachers learn to use the laboratory's hardware and software. Preservice and inservice teachers complete the modules in the laboratory, where one of the school's teachers is available one evening each week to help people who need assistance.

Faculty at Our Lady of the Lake have discovered that linking best practices to technology demands continuous change. The computer laboratory, established only four years ago, has had to be updated to keep pace with software changes and to provide access to the Web. This, in turn, has required updating the instructional modules.

Faculty are becoming increasingly proficient in use of technology, and each semester more faculty are modeling the uses of technology in their classes. Faculty have access to a classroom that houses a multimedia workstation and provides access to the Internet. Just as yesterday they might request a videocassette recorder to show a video, now they may reserve a portable media cart for class presentations. Through an effort sponsored by the CPDT, all faculty soon will have individual Web pages displaying syllabi and class assignments.

Our Lady of the Lake's professional development program spans three semesters, and technology is becoming an integral component of it. Preservice teachers must use the Internet in development of lesson plans and in other projects. They may use any one of four laboratories with Internet access. Some of the more adventurous students are beginning to use presentation programs such as Hyperstudio (which allows the user to import graphics and video clips from other sources) to develop teaching units.

St. Mary's University

St. Mary's University has integrated technology into preservice teacher training through a cooperative project with Roosevelt Elementary School in the Edgewood Independent School District and Huppertz Elementary School in the San Antonio Independent School District.

> *"Following a site visit to a local high school by Trinity students, a videoconference with the teachers and the administrators allowed students to ask follow-up questions in a discussion format. Another site visit would have been too time-consuming and would have conflicted with class schedules and the availability of transportation."*

a videoconference with the teachers and the administrators allowed students to ask follow-up questions in a discussion format. Another site visit would have been too time-consuming and would have conflicted with class schedules and the availability of transportation. Videoconferencing allows for the next best thing, person-to-person sharing of ideas across distance. The implications are that Trinity students and school people in the field have greater access to one another and can save transportation costs and time while increasing access. Meetings can take place within both institutions, thereby breaking down barriers. So far, these events have been very successful, adding to students' understanding of school life and to their research work.

Interns, mentors, and university personnel at school sites also use the Internet to communicate via E-mail. E-mail allows them to carry on "conversations" without back-and-forth trips, and that makes their work together more efficient and effective. Preservice students are required to use the Internet for research. On-line databases make the gathering of pertinent information thorough and practical.

Many interns also use multimedia programs such as Hyperstudio that allow them to devise sound and picture delivery of content and to record and present their portfolios on teaching. The portfolio, the summative assessment of the intern's year, becomes a public document shared with colleagues, peers, and potential employers. A digital portfolio drawing on multiple media sources allows for presentation of many layers of information. Public display of the process of becoming a teacher is important for teacher candidates as well as prospective employers, and multimedia software enhances it.

University of Texas at San Antonio

Faculty at the University of Texas at San Antonio are incorporating technology into the professional development sequence as well as into specializations such as early childhood and reading.

Preservice elementary school teachers taking methods courses in the professional development sequence—Approaches to Teaching, K–2, or Approaches to Teaching, 3–8—do field experiences as part of the courses. Whenever possible, they are trained to use software or technology that their mentor teachers are being or have been trained to use. For example, one group of preservice teachers was placed at Hutchins Elementary School in the South San Antonio Independent School District for their fieldwork. The same semester the teachers with whom they were placed were learning to use scanners to incorporate visual illustrations into writing assignments. The preservice teachers received

The project is a joint venture of the St. Mary's Science, Political Science, and Teacher Education departments.

Throughout the year, students from the two elementary schools come to computer laboratories and receive instruction on the use of the Internet. In the fall, political science professors use the Internet to instruct students on government issues and their roles as citizens in an information age. In the spring, earth science faculty introduce students to St. Mary's Geology Exhibit and encourage them to explore the geological history of metropolitan San Antonio. The university transmits all these sessions back to the students' home schools via the PictureTel Interactive video system, and it videotapes them for distribution to other interested elementary schools.

Another effort to integrate technology at St. Mary's is a program called Internet Pen-Pals. Elementary school students learn how to use computers to communicate via E-mail. Through the interdisciplinary reading program, faculty encourage preservice teachers to improve their technology and literacy skills via on-line discussions with elementary school students. In these sessions, elementary school students and preservice teachers review current reading assignments, compare classroom activities, and learn about each other's school and neighborhood. Also, as needed, elementary school students receive assistance with assignments and homework.

"In the fall, political science professors use the Internet to instruct students on government issues and their roles as citizens in an information age. In the spring, earth science faculty introduce students to St. Mary's Geology Exhibit and encourage them to explore the geological history of metropolitan San Antonio."

Trinity University

Trinity University uses technology in its teacher education programs, offering professional development opportunities through its Center for Educational Leadership. Both "interns" (prospective teachers) and their mentors receive technology training during the school year based on individual needs assessments. For example, some may require basic instruction in computer hardware operations; others, at a more advanced stage, are ready to prepare technology-oriented curriculum packages using the Internet for source documents. Often the training is available at the school site where mentors and interns work together.

During 1996–97, Trinity conducted programs on use and potential uses of (1) the Internet, (2) database resources for research, (3) communication systems such as E-mail, (4) multimedia software such as Hyperstudio, and (5) distance-learning technology such as videoconferencing.

Videoconferencing technology available at Trinity and various local schools allows classes from Trinity to interact with the schools. For example, following a site visit to a local high school by Trinity students,

training at the university in use of the scanner. When they went into the field, they were prepared to facilitate scanning projects.

In both Approaches to Teaching, K–2, and Approaches to Teaching, 3–8, prospective teachers engage in cooperative-learning exercises involving children's software and learn how to design similar activities for children using technological resources. Videoconferencing using real-time PictureTel interactive television units enables prospective teachers to interact with teachers in the field. For example, they may interview novice teachers for advice on classroom planning or experienced teachers who are practicing inclusion or working with linguistically and culturally diverse populations. Other goals of these methods courses are to acquaint prospective teachers with commercial software appropriate for young children and demonstrate how software and hardware can be integrated into lesson planning and instruction.

Prospective teachers enrolled in early childhood education evaluate software packages that are appropriate for use with young children. Groups of prospective teachers review commonly used packages, such as the Amazing Writing Machine, Spelunx, My First Incredible, Amazing Dictionary, and the Golden Book Encyclopedia. They also review professional literature to identify criteria for use in preparing a written evaluation. In their methods class, they demonstrate application of the software with a computer and a projection panel.

Graduate students in elementary education also learn to use technology in a variety of ways. They conduct bibliographical searches using various databases and Internet sites. They participate in cooperative-learning exercises incorporating software designed for children. Through a program called Inspiration, they are introduced to graphic organizers that visually display content. Following class discussions, a pair of graduate students is asked to produce a graphic organizer that summarizes the material presented. It is projected overhead for all to view, and a copy is printed for each student.

Introduction to Reading Problems is one of the specialization courses in which technology plays an integral role. In this course, preservice teachers working as reading tutors reflect on their work via E-mail, keeping in touch with their instructor or with a graduate student designated as their mentor, reporting what they are doing, evaluating sessions, and seeking guidance. By stepping into the mentoring role, graduate students also reflect on and apply what they are learning in their reading course work.

Prospective teachers document their use of technology in at least one lesson and describe how they have used computer technology as a literacy tool. In the future, technology will further enrich Introduction to Reading Problems through videotapes being made especially for the course. These videotapes will provide demonstrations to answer questions that tutors most frequently ask—for example, "How do I assess my students?" or "How do I introduce a new book?" Plans are for these videotapes to be pressed into CDs for easy distribution.

University of the Incarnate Word

Preservice teachers at the University of the Incarnate Word are exposed to, involved in, and expected to master and use a variety of technological tools. Before they enter the schools for assignments as teaching assistants, they have preparation in the use of technology in classroom instruction. Faculty encourage them to expand their technology skills by exploring with classroom teachers the variety of options available on the school campus.

Examples of preservice teachers' applications of technology include the following:

1. Using laptop computers provided by Incarnate Word to teach 12th-grade English composition in the classroom rather than in a computer laboratory
2. Requiring students to incorporate Powerpoint, a graphic display program, into their presentations at the end of a poetry unit
3. Using interactive computer technology in a seventh-grade science class to demonstrate ways to calculate, measure, and graph the topography of the ocean floor—formerly a time-consuming task accomplished with pencils and graph paper that failed to result in real images

> *"Without leaving their campus, Incarnate Word students "visit" the Region 20 Educational Service Center, a video marketing class at Sam Houston High School, and the Driscoll Middle School computer laboratory, where seventh-grade students demonstrate their Hyperstudio multimedia works."*

Another technological advance is the use of interactive videoconferencing equipment, which is available to all CEDE partners. Integrated mathematics and science classes and methods classes for preservice teachers are connected via videoconferencing to mathematics classes at Driscoll Middle School. This semester-long interaction enables preservice teachers to learn from and with middle schoolers without either group leaving its school.

Introduction to Education incorporates an interactive field trip to multiple sites, all in 75 minutes of class time. Without leaving their campus, Incarnate Word students "visit" the Region 20 Educational Service Center, a video marketing class at Sam Houston High School,

and the Driscoll Middle School computer laboratory, where seventh-grade students demonstrate their Hyperstudio multimedia works.

Incarnate Word faculty strongly believe that incorporation of technology has improved instruction in the professional development/ licensure courses and in all the courses taught in the department. In their end-of-program evaluations, "teacher apprentices" (student teachers) repeatedly support the value of their hands-on preparation for using technology. Mentor teachers report that they are pleased with the skills, the theory, and the validation of technology as a teaching/learning tool that the teaching apprentices bring to the student teaching semester.

Summer Institutes

From CEDE's inception, partners recognized that in addition to providing professional development opportunities for prospective and practicing teachers, they had a responsibility to recruit prospective teachers, especially from minority groups. As part of this responsibility, CEDE developed two summer institutes for prospective teachers.

The Secondary School Summer Institute is for high school students. Recruited primarily from CEDE's partner school districts, participants have completed at least their freshman year of high school, taken core curriculum courses prescribed by the Texas Education Agency, maintained a "B" average, and indicated an interest in teaching as a career. Over a three-week period, they receive information about the teaching profession, attend seminars on how technology is changing the nature of instruction, and work with practicing professionals in schools and other agencies involved with children and young adults.

The Collegiate Institute is a three-week program for students who have completed the freshman or sophomore year of college. Participants must have a 3.0, or "B," average in courses necessary for entrance into a teacher education program. They receive information from university faculty, elementary and secondary school teachers, principals, and personnel directors on what to consider in choosing teaching as a career. They also get an introduction to the uses of technology in classroom settings. Students receive tuition scholarships and undergraduate credit from their institutions for attending the institute.

In the first four years, more than 200 high school students and 70 college students attended the institutes. Of this number, better than 60 percent were minority students. Follow-up surveys indicated that about 95 percent of the high school students who had attended planned to enroll in postsecondary education, and of these nearly 40

percent wanted to become teachers. Further, all the college students who had attended were enrolled in, or had graduated from, teacher preparation programs.

Three Years of Effort: University of Texas at San Antonio and Brewer Elementary School

The University of Texas at San Antonio pays particular attention to helping teachers incorporate technology into their instructional programs in effective ways by ensuring that preservice teachers are placed in technologically rich contexts for their field experiences. This case highlights three years of effort at Brewer Elementary School, one of the university's PDSs in the San Antonio Independent School District.

As a result of the three-year initiative, university personnel believe that the most effective way to promote the use of technology in a school is by developing a site-specific technology training plan. Because of this, a brief description of Brewer Elementary, its instructional emphasis, and the surrounding community is included.

The Context

Brewer Elementary serves approximately 500 students from prekindergarten through fifth grade. Ninety-nine percent are Hispanic, and 92 percent receive free lunch. About 96 percent live in the federally subsidized housing development across the street from the school.

The year before the inception of CEDE, the university and Brewer Elementary had begun working collaboratively. Brewer Elementary faculty had identified literacy as the focus for the collaborative program. The school was developing a multicultural "read-aloud" program in English and Spanish designed to give students opportunities to experience challenging literacy instruction related to the culture of their community and school and to engage in extensive voluntary reading. The work of CEDE began in this context.

Previous Technology Use at Brewer Elementary

In the two years before Brewer Elementary became a PDS, technology played a minor role in the life of the teachers and the students. The school had a computer laboratory with 20 computers donated by a local business; however, teachers rarely used it. Also, each third-, fourth-, and fifth-grade classroom had five computers and a printer, and each fifth-grade classroom had a laptop computer as well. Teachers made only minimal use of this equipment, however.

Through CEDE, funds became available for additional equipment and for technology training. Brewer Elementary received a workstation

that included a computer with a CD-ROM drive, a modem, a laser printer, and a scanner. It was stored in the computer laboratory but set up on a cart that could be moved around the school to maximize its use in classrooms. Grant funds also paid for a video camera, a digital camera, a computer projection panel, various pieces of software requested by the school, a satellite downlink system, and access to one of CEDE's compressed-interactive television units.

> ***"Brewer Elementary received a workstation that included a computer with a CD-ROM drive, a modem, a laser printer, and a scanner. It was stored in the computer laboratory but set up on a cart that could be moved around the school to maximize its use in classrooms."***

Technology Training in Year 1

Despite access to a significant amount of technology before the advent of CEDE, both the principal and the teachers at Brewer Elementary readily admitted that technology played only a peripheral role in their lives because they had had no instruction in its use.

During the first year of the technology initiative, the university relied on one of its partners, the Region 20 Service Center, to plan and deliver technology training. The training had three major goals: (1) to provide teachers with an overview of the technological innovations that were occurring in classrooms across the nation; (2) to train teachers to use basic applications; and (3) to train teachers to use TENET (the Texas Educators Network). Eleven teachers from across the grade levels, selected because of their previous professional training, were designated as mentor teachers who would work with preservice teachers and participate in technology training. In addition, a teacher with technology expertise was selected to serve as technology coordinator, responsible for supporting teachers' efforts to integrate technology into their instructional programs and professional lives.

The overview focused on uses of a variety of basic applications and multimedia and productivity tools. The purpose of the TENET training was to enable teachers to connect on-line with colleagues who were exploring technology and to tap into a host of educational resources. Teachers typically attended monthly sessions of three to four hours each at various central locations such as the university campus or the regional service center.

Technology Training in Year 2

Early in the second year, a university facilitator organized a planning session for the 11 mentor teachers to devise a technology training plan for year 2. Asked to identify areas in which they would like further training, not a single teacher had a suggestion. Focusing on the "big technology picture" had not helped them see how technology might meaningfully support their own programs.

"The first production of Project STAR broadcast schoolwide was a huge success. Students who reviewed books became immediate stars. This motivated other fourth and fifth graders to read books and write more book reviews using classroom computers so that they too might be included in a videotape."

After a number of meetings, a new plan emerged, built on four principles:

1. Existing curricular goals will be the basis for integrating technology into the life of the school.
2. Teachers are most likely to apply what they learn from technology training when they are trained on the computers that they and their students will actually use.
3. Training is most likely to have an effect when teachers are trained with grade-level colleagues who can serve as support systems when teachers begin to apply what they have learned.
4. To help teachers overcome their fear of using technology in instruction, training must initially target the most basic uses of technology.

With these principles in mind, the university facilitator centered the next technology planning session on the school's literacy program, which had been the major focus of school-university collaborative efforts before CEDE. The teachers brainstormed ways of strengthening the literacy program with technology. Because of their commitment to improve students' literacy, the use of technology to support this effort made perfect sense. Within half an hour they developed a plan for Project STAR (Students, Technology, and Reading).

Project STAR was a technology-based program designed to foster voluntary reading and to help students acquire various language arts strategies and skills. Fourth- and fifth-grade classes participated. Students read extensively to select a book that they would like to review on videotape for the entire school. One videotape featuring approximately 15 book reviews was to be produced during each nine-week school session. Teachers instructed students in how to compose enticing reviews. Because computers had previously been used minimally, students were required to compose their book reviews on computers. Personnel from the regional service center came to Brewer Elementary to train the students and the teachers in use of the word processing program on the classroom computers. Students submitted their favorite book reviews for possible inclusion on a videotape. Under the guidance of the school's technology coordinator, students also assumed responsibility for videotaping Project STAR productions.

The first production of Project STAR broadcast schoolwide was a huge success. Students who reviewed books became immediate stars. This motivated other fourth and fifth graders to read books and write more book reviews using classroom computers so that they too might

be included in a videotape. Project STAR accomplished what it was intended to accomplish; it helped remove teachers' hesitancy to use computers for basic word processing. In subsequent years the project has been extended to include lower grades.

Technology Training in Year 3

By the third year, fourth and fifth graders and their teachers felt confident using word processing programs. To help the teachers take yet another step forward in using technology, university facilitators invited them to participate in a community-based research project that would culminate in student-created multimedia presentations. The teachers already were involved with the university in developing multicultural units that incorporated literature related to the students' community and school experiences. The project for the third year was to build on and extend these community connections while engaging the teachers in development of interdisciplinary units and involving a university professor and preservice teachers enrolled in the methods course Approaches to Teaching, 3–8. The initiative also was designed to capitalize on previously acquired technology skills while introducing new and more sophisticated uses of technology.

The teachers were receptive to the new project, which they named the Community Connections Collaborative. On the basis of surveys of students' interests, two groups were formed. One group chose to study the murals that decorated buildings in the housing development across the street from the school. These murals explore different Hispanic social, political, religious, historical, and cultural themes. The second group opted to do a comparative study of modern and traditional medicines commonly used in the local Mexican-American community. In addition to relying on traditional ways of reporting research findings, each group was to use Hyperstudio to create a multimedia presentation.

At the beginning of the project, none of the teachers had experience working with community research projects or with multimedia software. To introduce them to the scanner, the digital camera, and Hyperstudio, a Saturday inservice session was held. Following this training, a consultant experienced in both community research and creation of multimedia presentations came in for two days. On the first day, the consultant introduced small groups of students from each grade level to Hyperstudio. On the following Saturday, the consultant helped teachers develop storyboards for the students' Hyperstudio presentations and gave them additional training in the use of the workstation equipment and Hyperstudio.

> *"Only recently has there been recognition that training in appropriate use of technology and its application to the curriculum is important if technology is to be successfully integrated into education."*

This third-year technology initiative provided Brewer Elementary students and teachers with the opportunity to develop far more sophisticated skills in technology, and it did so by integrating technology into a culturally meaningful curriculum project. The technology legacy of the Community Connections Collaborative is clearly evident at the school today. For example, students prefer to use the Hyperstudio presentation as the reporting mode for research and writing. Students' interest in Hyperstudio is so great that several teachers have started a Hyperstudio Club for them.

Preservice teachers placed at Brewer Elementary now participate in a school where technology plays a central role across the curriculum. This initiative also has changed how technology is integrated into Approaches to Teaching, 3–8. It has become a requirement for all university students taking field-based courses at Brewer.

CONCLUSION

Over the past twenty years, as education institutions have employed technology to improve school teaching and student performance, the major emphasis has been on obtaining hardware. Only recently has there been recognition that training in appropriate use of technology and its application to the curriculum is important if technology is to be successfully integrated into education.

Most teacher education institutions have expended enormous amounts of time and energy in acquiring equipment for their students and faculty. Associated training in learning how to apply technology effectively has followed, often in a manner not fitting the curriculum or the needs of the students. The education in technology provided to both preservice and inservice teachers must be broad enough to enable them to continue learning about technology throughout their careers. This would be consistent with many, if not most, of the reform efforts on technology in teacher education cited in the NCATE (1997) report.

During the past five years, the CPDTs have begun to deal with these issues in a collaborative model that has benefited both preservice and inservice teachers as well as PreK–12 students throughout Texas. In an era when educators are held accountable for both knowledge attainment and costs, CPDTs have advanced toward the goal of increasing the professional and technological training of preservice and inservice teachers throughout the state while improving overall student performance.

RECOMMENDATIONS FOR MOVING AHEAD

Various organizations and panels have made recommendations about how to move technology ahead in schools and teacher education programs. One such group is the Technology Task Force of NCATE. A recent article describing the task force's work (Cooper & Bull, 1997, pp. 103–5), suggests eight guidelines for how schools of education can infuse technology into curricula and prepare teachers who can use technology effectively in their professional practice:

1. Develop a vision and a technology plan and update it every couple of years.
2. Support local schools' efforts and learn together.
3. Create a school of education culture that fosters exploration and a fearlessness about technology.
4. Provide incentives for people to use technology.
5. To encourage sharing among faculty members, provide them with free software that you want to encourage people to use.
6. Support your "product champions," the people who are pushing the envelope and staying ahead of the curve.
7. Involve people and invite all to participate and to shape the technology agenda.
8. Allow a sufficient gestation period before expecting results.

THE AUTOMOBILE ANALOGY REVISITED

To understand the challenges educators face in transforming schools and teacher preparation programs, it is helpful to revisit the automobile analogy. Initially automobiles were a novelty, and many people questioned their potential to influence society significantly. Furthermore, most people doubted that the majority of Americans could ever learn to operate, let alone afford, such a contraption. Today many people hold similar views about computers and other types of advanced technology.

In the late 20th century, people consider cars a necessity because cars get them where they want to go more quickly and conveniently than walking or riding a horse or taking a train does. Likewise, people value technology because it gets them the information they want, enables them to solve problems quickly, and greatly increases their learning, efficiency, and productivity.

Just as there are car enthusiasts, there are technology enthusiasts, but in both instances most people are simply interested in how technology can assist them in their professional and personal lives.

There is a learning curve involved in both driving a car and using technology. Learning to navigate the streets or cyberspace is bound to

> *"Novices in all new endeavors need support; to avoid disasters, leaders must be ready to provide it."*

involve a fender bender or two or a computer crash now and then. When conditions change drastically—say, a rainstorm begins or a new operating system is installed—additional instruction helps novices (even experienced users) adapt. Novices in all new endeavors need support; to avoid disasters, leaders must be ready to provide it.

Suppose a company buys a fleet of cars to increase employees' productivity and efficiency, and the cars then sit unused in the parking lot because employees do not grasp the usefulness of this major investment. The company will either increase employees' knowledge and skills or liquidate the investment and apply the revenues to other priorities. A similar mindset is valid in the use of technology in education.

Like cars, technology solves problems but creates them as well. People are inconvenienced as highways are expanded. In technology, educators may be inconvenienced as "electronic highways" are built and connected, as new hardware and software are introduced, and as other items become obsolete. Just as the parts for a Chevrolet are not interchangeable with those for a Ford, there are compatibility problems in computer hardware and software. Just as some bad people use automobiles to accomplish criminal ends, a few dangerous persons expose Internet users, especially children, to pornography and other inappropriate material. "Problem drivers" imperil themselves and others; misguided technology users break in to confidential files or "plant viruses" in computers. Serious problems exist with both 20th-century inventions, but returning to "horse and buggy" days is not an acceptable option.

Car owners and technology users can expect continuing expense in operating, maintaining, and replacing their machines. People buying a new car or a new computer realize that there will be repairs and probably successors in their lifetime.

Someday children may go to school in Jetson mobiles, toting their laptop computers. Until then, educators should chart their course carefully, keep moving aggressively in the chosen direction, and be realistic about the complexities involved.

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